Evolutionary Genetics – Mitosis Exercise

1. Nuclear division in eukaryotes leading to the formation of two daughter nuclei, each with a chromosome complement identical to that or the original nucleus (Sadava et Al, 2008)

Mitosis occurs for many reasons vital to the maintenance of the organism, the main being growth, development and repair. It also plays a role in sexual reproduction with meiosis.

The process begins after the nucleus replicates its DNA. As mitosis begins, the chromatin (DNA and proteins) supercoils, condensing into visible chromosomes formed of two identical chromatids. The chromatids then part, one enters each of the forming daughter cells, distributing the chromosomes equally and giving both a full set. The final stage is Cytokinesis, the division of the cytoplasm. This occurs in different ways in plant and animal cells, due to the plant cell wall. Reproduction by mitosis results in genetic consistency as the new cells are identical to the original parent cell.

1. X-rays can cause mitotic arrest in cells, the inhibition of division and breakage and re-arrangement of the chromosomes. This means the X-rays affect the DNA immensely. If the cells are mitotic, the damaged DNA will be copied to all new daughter cells. It is hugely detrimental as the damaged DNA is then passed on possibly throughout the whole organism. This can cause the developments of cancer due to division errors.
2. The chromatids in mitosis are parted by spindle fibres made from tubulin; they attach to the kinetochores and pull the chromatids apart. If cells are exposed to Colchicine, which binds to free tubulin and prevents its polymerization into microtubules, mitosis fails. The spindle is normally maintained by continuous addition and loss of tubulin subunits. Tubulin addition is blocked by Colchicine, tubulin loss continues until the spindle disappears, stalling the cell in the middle of mitosis as it is unable divide its chromosomes.
3. Polyploidy - Possession of more than 2 entire sets of chromosomes. (Sadava et al, 2008). This arises from chromosome duplication (autopolyploid) or from combining chromosomes of two species (allopolyploid). Autopolyploids arise e.g. when normally diploid cells duplicate their chromosomes, resulting in tetraploid individuals (4 sets of chromosomes). The individuals are reproductively isolated from others of the species as meiosis fails. Allopolyploids arise from hybridisation of two different, closely related species, forming a new species that is often fertile.
   1. *Spartina. –* Grasses from family Poacaea. Original diploid parents are native to coasts of Atlantic Ocean (America and Europe). Two species met when one arrived on boats from America; they ultimately formed a hybrid *Spartina anglica,* an aggressive fertile species. It has spread over the globe wiping out other species in its path. This shows the importance of hybridisation in the invasive success of species, and also the dangers.
   2. *Tragopogon. –* part of the sunflower family, has been inadvertently spread around the world from its ancestral region, Eurasia. Three separate species were introduced into America. Polyploid hybrids were later discovered all over the world and today they are more widespread than their diploid parents. The success of hybrid species show how many varieties of plants could have originated as polyploids.
   3. *Nicotiana* - the tobacco family, a hugely popular plant grown to provide the tobacco for cigarettes and cigars. The origins of the cultivated tobacco are unknown and DNA sequencing has been used to try and trace its ancestry back to the original plant that the Aztecs discovered. Several types of tobacco plant are used a model organisms in genetics.
   4. *Triticum* – bread wheat, a type of wheat ideal for bread, one of the first cultivated on a large scale giving a high yield harvest. The bread we use nowadays is a hybrid of the original bread wheat; we do not know both its parental species, sequencing the genome had helped to find one. Finding and propagating the original bread wheat is a goal yet to be completed.

References:

Sadava D, Heller C, Orians G, Purves D , Hillis W (2008) Life: The science of biology 8th Edition. Sauer Associates, Sunderland.

Alberts B, Bray D, Hopkins K, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2004) Essential Cell Biology 2ND Edition. Garland Science, New York.